Claims

What is claimed is:

1. A video camera with enhanced image clarification comprising: means for producing a sequence of digital images of an object, which object is continuously distorted by time-varying aberrations of an optical medium; an adaptive optic device arranged for receiving said sequence of digital images and canceling said aberrations; a digital processor connecting with said adaptive optic device for performing real-time control of said adaptive optic device; and a sequential diversity processor connecting with said digital processor for providing real-time control signals to said adaptive optic device to thereby cancel said aberrations.

2. The camera of claim 1 wherein said sequential diversity processor utilizes diversity D(k), along with current and previous data images, I(k) and I(k-1), as diverse images to estimate Q(k) a residual phase aberration in said optical system whereby D(k+1) = -Q(k).

3. The camera of claim 2 wherein T(k) is added to D(k+1) whereby T(k+1) = T(k) + D(k+1).

4. Sequential diversity imaging apparatus comprising: means for receiving a sequence of images of an object, said object being continuously distorted by a changing optical medium; an AO device in optical proximity with said receiving means for canceling aberrations introduced by said medium to thereby provide solely adapted in-focus images of said object; a detector array arranged for receiving said solely adapted in-focus images and producing digital image representations thereof; and a sequential diversity processor connecting with said detector array and said AO device, said sequential diversity processor receiving said digital image representations from said detector array and providing sequential control signals to said AO device to enable said AO device to cancel said aberrations.

5, The sequential diversity imaging apparatus of Claim 4 wherein said sequential diversity processor calculates a sequence of diversities corresponding to said aberrations according to a predetermined diversities equation whereby

W(k)= unknown distorting wavefront at time k.

T(k) = phase put on the AO at time k.

C(k) = compensated phase to be estimated by a diversity algorithm = W(k)+ T(k) (1)

I(k) = Measured image at time k.

D(k) = Diversity phase.

I(k-1) is the first image and I(k) is the diversity image and the diversity phase is the change in the AO phase from time k-1 to time k. Thus,

$$D(k) = T(k) - T(k-1) \quad (2)$$

The phase diversity algorithm is set up to estimate C(k), the compensated phase at time k.

$$Q(k) = W1(k) + T(k), \qquad (3)$$

set $$T(k+1) = -W1(k), \qquad (4)$$

Solving (3) for W1(k) and substituting it into (4),

$$T(k+1) = -Q(k) + T(k),$$

$$T(k) = -Q(k-1) + T(k-1).$$

Insert equation (5) into (2) as follows, D(k)= (- Q(k-1)+ T(k-1))- T(k-1)= - Q(k-1) (6) to provide the specification for the diversity phase at time k.

6. The sequential diversity imaging apparatus of Claim 4 wherein said control signals for said AO device are determined according to the following control equation:

T(k) = T(k-1)+ D(k) (7).]

7, A method for determining aberrations caused by an atmosphere and controlling an AO device in an optical system to eliminate said aberrations comprising the steps of:
providing a plurality of solely in-focus images, each of said solely in-focus images having a known diversity selected from the group consisting of phase, wavelength, or spatial shift;
determining an unknown object and parameters of said atmosphere causing said aberrations;

generating a plurality of sequential frames of a video recording of said object to provide diversity images; and

inputting said diversity images to a sequential processor connected with said AO to thereby control said AO and eliminate said aberrations.

8. The method of Claim 7wherein said sequential diversity processor calculates a sequence of diversities corresponding to said aberrations according to a predetermined diversities equation wherein:

W(k)= unknown distorting wavefront at time k.

T(k) = Phase put on the AO at time k.

C(k) = Compensated phase to be estimated by a diversity algorithm = W(k) + T(k) (1)

I(k) = Measured image at time k.

D(k) = Diversity phase.

Said diversity phase defining a change in the AO phase from time k-1 to time k. Thus,

$$D(k) = T(k) - T(k-1) \quad (2)$$

The phase diversity algorithm is set up to estimate C(k), the compensated phase at time k. Set the estimate Qk from equation (1),

$$Q(k) = W1(k) + T(k) \quad (3)$$

W1(k) is an estimate of W(k), the unknown phase at time k. At time k + 1 the AO phase is set to the negative of the unknown wavefront at time k+1.

Set T(k+1) = - W1(k),where w1 is the wavefront at time k(4)

Solving (3) for W1(k) and substituting it into (4),

$$T(k+1) = - Q(k) + T(k),$$

set $T(k) = - Q(k-1) + T(k-1)$.

Insert equation (5) into (2) to get

$$D(k) = (- Q(k-1) + T(k-1)) - T(k-1) = - Q(k-1) \quad (6)$$

to provide the specification for the diversity phase at time k.

9. The method of Claim 7 wherein said control signals for said AO device are determined according to a predetermined control equation.